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A RANDOM TALK ON COMPUTER LANGUAGE "COMPUTER SOFTWARE AND THE USE OF COMPUTER"

by

Kan Ch'ao

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A Random Talk on Computer Language

"Computer Software and the Use of Computer" (3)

Kan Ch'ao

Language is a tool by which people exchange their ideas. It can be therefore said that the function of language is to exchange information. Chinese, English and other natural languages, for instance, are all used to exchange informations among peoples.

When people want to exchange information with a computer, they also use language, and the language thus used is called "computer language".

Computer is made by man and is used to serve people. In the relationship between man and computer, man is always at the position to direct. So the main use of "computer language" is for man to give order to computer and the computer carries the order out. When man wants the computer to report back the procedures as well as the result of carrying out that order, "computer language" again is used for the work of reporting. When several computers are connected together, the "computer language" is used to exchange information among the computers. In addition, when people want to exchange experience of using computers, they also use "computer language".

An electronic computer is always used to solve arithmetic problems and other complicated matters, such as to control the launching of missiles and the attacking of targets, and to help design new model aircrafts. But a computer itself can only perform some separated and simple operation, which in techincal terms is machine instruction. This kind of machine instruction can be understood and carried out by a computer, and it is called machine language.

A computer understandsonly machine language. Programming by using machine language is no easy task and the efficiency is low. There is, however, one remedy that is to train specialized programmers. The daily work of a specialized programmer is programming. As "dexterity comes out of long practice", the efficiency in programming will thus be improved. Nevertheless, it takes long time to train specialized programmers, so it is not very promising for more people to use computer. And,in fact, the efficiency in programming by professional programmers is not very high. Another problem is that each computer can understand only one set of machine language which is used on it. One program can be applied to one computer and it will be not good for any other. In a true sense, a specialized programmer is "specialized" and each machine has to train its own programmer. So it needs a great many programmers if the machines are fully employed. Obviously, this is wasteful and violates the principle of doing more, faster, better and more economical.

How to improve efficiency and how to enable more people to use computer? The key problem is that the machine language is too novel and too hard to remember. In the earlier days after computer had come into being, some one tried to improve the language used on the computer. The language suggested at the early time is called assembly language. One of its characterisctics is that it uses symbols which are easy to remember to indicate numerical codes which are usually difficult to remember and easy to be confused. For instance, it is not direct to use 008 to indicate an addition instruction and it is not easy to remember either. But in assembly language,it uses "+" or "ADD", so it is direct and easy to remember. Another advantage of assembly language is that unlike machine language, it is convenient for changing programs. Furthermore, the techniques used in making programs are simpler than those used in machine language and they are also easier to manipulate. Ever since the advent of assembly language, the efficiency in programming has been greatly improved and it is more convenient for more people to use computer.

Although the assembly language has helped to improve the efficiency in programming, it remains to be a "low garde" language, because one computer can only have its own assembly language,and it is impossible to communicate among different computers. The format of programs compiled in assembly language is similar to that in machine language, and people are not familiar with it. For instance, a mathematic formula A = B x C + D (this is mathematic language, with which people are familiar), in assembly language it will be:

```
LOAD        B
MUL         C
ADD         D
STORE       A
```

Among these instruction memory codes, LOAD means to take, MUL and ADD are the first three letters of MULTIPLE and ADDITION, and STORE means to keep for future use. The whole program means to take B multiplied by C and added D, and then to store them in A.

Evidently, the difference of assembly language from mathematic language is rather great. Till the 1950's, a program language which is used to calculate numerical value has been developed. One of its characteristics is that it is very close to the general mathematic language. For instance, a mathematic formula A = B x C + D written in program language is just like this. Those which represent this language are algorithmic language "ALGOL60" and formula translator "FORTRAN" (Figure 1). ALGOL60 and BCY, the latter belongs to the same system with the former, are the most popular ones, and almost every kind of machine is equipped with this kind of language. Recently, FORTRAN is also widely used. The strong points of these languages are manifold. Anyone who has some common knowledge of mathematics can easily grasp it and use it. Programs compiled in this language can be used in various machines. This is a great convenience. In solving practical problems, the efficiency will be high if the program compiled in this language. For example, one factory using China made machine DJS-21 to desing a camwheel, it will take about one month if they use machine language to compile program for a computation on computer for a few minutes. But it takes about one day if they use ALGOL60 to compile the program, and it takes only a few minutes for both transaltion and computation. Evidently, the efficiency is very high.

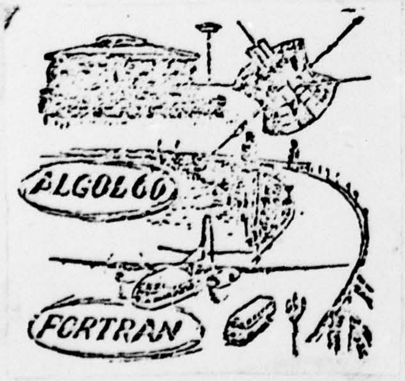

Figure 1 There are several different kinds of computer languages. Among them ALGOL60 and FORTRAN are used to calculate numerical values in engineering desing and science research.

The characteristic of the computer language used to calculate numerical value is that the process of calculation is relatively complicated, such as to solve differential equations. But the quantity of data required is small. Another problem in practical application is just contrary to this. The calculation is very simple and it requires only addition and substraction, but the quantity of data processed is very large. But this language is not convenient for processing such data as wage schedule of the workers of a factory and the inventory of bank accounting books. For solving these problems, there is a specialized data processing language. It is COBOL. This language can be easily understood and used by financial and accounting personnel, who have only some kind of short-term training (Figure 2).

In computer science, a kind of data sheet is often used. The sheet is made of series of data connected one after the other, and the first one can tell what is the next. So it is very easy to pick up what is wanted. For processing this kind of sheets, there is a specialized sheet processing language, and the represntable one is LISP.

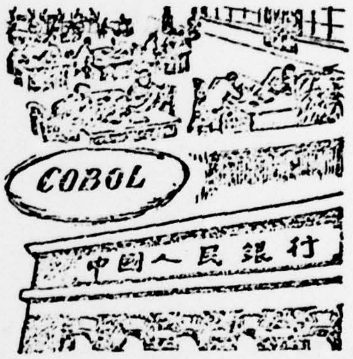

Figure 2 COBOL is specifically used for data processing

In the area of publication, intelligence indexing and library research, computer is very useful. The language which is good in these areas is character-symbol series processing language. The representable one is SNOBOL4, which can be used in several machines.

The computer languages mentioned above are of several different types, such as those for numerical value calculation; data processing; sheet processing; and character-symbol series processing. The first kind is used widely in industrial technology, science research and national defense. The second kind is used mostly in national economy, business administration, government administration and even personal daily life, such as buying airplane ticket and making bank deposit. PL/1 and ALGOL68 are a large type independent language which has all the characteristics of those languages mentioned above. PL/1 is a convergent language which collectively has all the characteristics. ALGOL68 is a language which can be expanded. It provides a set of basic language and the ways of expanding it. The user of the language can expand any part of its function according to his need. ALGOL68 is very strict in theory and rather difficult to understand.

In science research and engineering computation, it needs not only value computation and formula calculation as well. Taking $(a + b)^2$ for example, if $a = 1$, and $b = 2$, then by using any of the value computation language, such as ALGOL60 and FORTRAN, it [illegible] immediately become known that the sum is 9. If the value of a and b [illegible] been determined, the formula should be expanded into $a^2 + 2ab + b^2$. For such a kind of work, a formula calculation language has been developed. It can be used to solve multiple equations, matrix calculation, formal differentiation and formal integration, and even for proof of some mathematic theories.

Nowadays, the scope of using computer has been unprecedentedly expanded and it has gone far beyond the areas of national defense and advanced science. In science research, national economy, engineering technology, business administration, library, intelligent agencies, library, bospital, filing office, public security investigation and people's daily life, computers are used. In order to improve the working efficiency of computers, in various areas where computer is used, specialized language is developed to suit the special need, such as machine making language, ship shaping language, construction engineering language, earthquake predicting language, bank reporting language, airplane wing design language, etc..

Besides, for various specialized problems, there are specifically designed languages, such as linear planning language, mathematic statistic language, matrix calculation language, dynamical structure language and others. These languages can automatically choose the best way to solve the problems which have been charged to them. A linear equation, for example, can have several different ways to solve, but this specifically designed language can according to the characteristics of the problem automatically find a most suitable solution, and consume leass time to find the most accurate answer. It is therefore very convenient for the users, and they need not spend their time to choose what is the best way to compute. This kind of language is different from what has been mentioned above. It is not made for use in some special area but rather for special problems.

The characteristics of computers of the new generation are that their speed is high and their memory space is large. For improving efficiency in using computer and solving the contradiction between the high speed of computer and the low speed of man's operation from the operation stand, there has developed a different-time end system. One computer can have several, several tens and hundreds of different-time ends so that more than one person can at the same time use one and the same computer at different ends, and the computer in rotation apportions each person time for his operation. Because of the high speed of the machine, when one person punches a key, the machine has calculated thousands and million times, so he will never know that there is another person who is using the machine at the same time . Thus everyone can easily work with his own program and does not have to worry about wasting the time that the machine has afforded. He can even ask the machine for"help" when he is working with his program. He can try some conceived new plan and ask the machine to calculate it and give him an answer. In this fashion, a person and a machine can engage in a dialogue. The language used in such a special situation is called conversational language. The representable language of this kind is the BASIC language, which has been introduced in the March Issue of this journal.

The concept of computer language has been briefly introduced as above. Machine language and assembly language can only be applied to some specific machine, so they are low grade languages. In technical terms, they are machine-oriented languages. The independent languages, such as ALGOL60, FORTRAN, COBOL and BASIC, can be used on machines of every kind to solve every kind of problems. In technical terms, they are procedure-oriented languages. The user of computer must tell the machine what to do and how to do it when he uses this kind of language. There is another kind of language, such as mathematical statistic language, which can be used on every kind of machine but it is good only for solving some specialized problems. In technical terms, this language is problem-oriented language because it is oriented to solve specialized problems. The user of this language needs only to tell the computer what to do, and the computer will choose a proper way to do it. All these languages are independent languages. Those which can be used only for solving some specialized problems in some specific areas, such as airplane wing design, are called dependent or specialized languages.

Today, there are about three hundred different computer languages in the world, and the new ones continue to thrive. Among these languages, the dependent or specialized languages constitute a majority, and the independent languages are less than one hundred in number. Those which are used widely and considered the most important ones are eight: non-conversational ALGOL60, FORTRAN, COBOL, PL/1, ALGOL68 and conversational BASIC, LISP and APL.

In recent years, there has developed a new language that is the system program engineering language. It can be used to compile programs and administrate programs and some even greater and more complicated operation systems. In the past, such systems were written by using low grade languages, such as machine language and assembly language. But their efficiency is low and the quality of work is poor. Time and energy are wasted. Their defects are really irremediable. Often there is a whole sheet of number codes, which no one can understand and even those who wrote them can forget them after a short period of time and cannot understand what they are all about. There is an operation system in some country abroad, for instance, they spend 6,000 man-year, namely 6,000 people working for a whole year, the work quality is very poor although they continuously try to improve it. For this reason, a system program engineering language is developed to remedy the defects of the low grade languages. It so far proves very successful. The representable ones are system assembly languages, such as BLISS, PL360 and PL/S.

The simulation language is also worthy of a mentioning. Generally experiment is expensive in terms of time, money and manpower. In this area, however, a computer can be found useful. It can be used to simulate the experiment situation and to predict the possible outcomes of the experiment. In production administration and public service (such as telephone company and bus company), some complicated and unexpected situation can come at any time, simulation language can be used there to compare and to choose the modulation plan. The representable simulation language is SIMULA67.

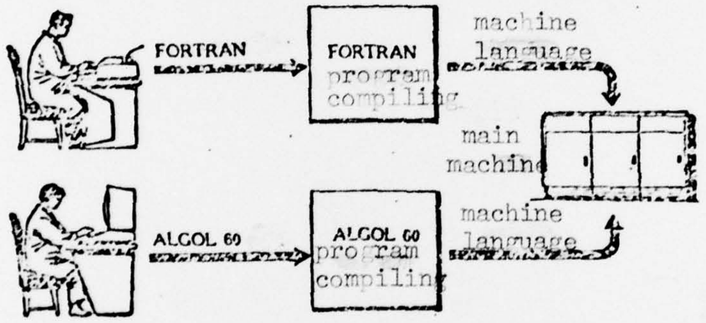

Figure 3 The more program compilings are carried by a computer, the more languages the computer will understand.

So many languages have been discussed above. If a computer can only understand machine language, how can it understand so many of those "computer languages"? It is through "translation" of compiling programs and interpreting programs that the languages which cannot be understood by machine, based on their grammar and meaning, are translated into those which can be understood by machine. A computer at the beginning can only understand machine language, but when it is given ALGOL60 through translation, it begins to understand ALGOL60. The more translations it is given, the more languages it can understand (Figure 3).

There may be another question that program language can be carried out only through translation by a computer,doesn't that computer have to spend a lot of time? The answer is "Yes". Because the machine spends some time, man can then save a lot of his time. One of the characteristics of a computer is that it has a very high speed. It can calculate hundred thousands and even million times per second. People are now taking advantage of this high speed and try to correct the shortcomings of the machine language. In the example of camwheel calculation mentioned above, if it uses machine language, it will have to spend one month, but it takes only one day when it uses program language. For translation, the machine spends only a few minutes,and these few minutes mean a month that a man has to spend on this subject. Isn't this a marvelous accomplishment of doing more, faster, better and more economical? Moreover, programs compiled by program language are independent, and next time when someone uses computer to calculate a camwheel, he can use this one and the same program,and does not have to spend any time in programming.

Someone may like to ask why "natural language" cannot be directly used on computer? Compared with program language, natural language can be very effective in overcoming the shortcomings of machine language. But natural language is too rich and too independent, and, at this point of time, a computer cannot yet use natural language. In the format of writing and the rules of sentence structure, the requirement of computer language is much more strict than those of natural language. For instance, in a Chinese phrase, "a glorious people's envoy", 'glorious' and 'people's' can be treated as two modifiers of 'envoy'. It can also be interpreted that 'glorious' modifies 'people'. In computer science, this is called "double-meaning". Computer language is not allowed to have "double-meaning". So the time when a computer can use natural language may be still far away.

(Illustrations by Chang Chen-yeh)

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